THE

Malayan Agricultural Journal.

Vol. XII. May, 1924. No. 5.

BATRACHEDRA ARENOSELLA, WALK., (COSMOPTERYGIDAE) IN RELATION TO THE NUT-FALL OF COCONTUS.

By G. H. Corbett and B. A. R. Gater.

Batrachedra arenosella was first described by Walker (1) from New Zealand under the name of *Gracilaria arenosella*. It is a very widely distributed species, having been subsequently recorded in Australia, Tasmania and British Guiana, and was referred to the genus *Batrachedra* by Meyrick (2), who also described it under the name of *B. psilopa*. Bainbridge Fletcher (3) records it from various localities in India.

It was first noticed in Malaya on the Bernam River, Perak (4), in the early part of 1922, and since then has been found in the majority of States in the Peninsula. Owing to the fact that the sole food plant in Malaya appears at present to be the coconut palm, it was considered that the insect might be of first-class economic importance. As far as can be seen from the available literature, *B. arenosella* has not previously been recorded on coconuts, the only reference to a food plant being from Queensland, on the seeds of *Juncus* (5). *B. amydraula*, Meyr., is recorded on the date palm in Iraq (6).

Damage Caused by the Insect.

The insect was first observed in the pupal stage on a newly opened spike. The female flowers of the spike in question showed signs of damage which was attributed to the caterpillars of *Tirathaba*, sp. near *trichogramma*, Meyr. (Pyralidae). No signs of the caterpillars of the latter could, however, be found, but on a closer examination of the spike the small white cocoons of *B. arenosella* were found at the base of the inflorescence. Several unopened spikes were then examined, which revealed the presence of numerous caterpillars and cocoons, and in some cases the newly emerged moths.

Both the male and female flowers of the inflorescence are gnawed by the caterpillars, which are frequently found feeding inside

the male flowers. The male flowers are seemingly attacked more often than the female, but in either case a brown discolouration of the tissues starts at the point of attack and sometimes travels downwards along the stem of the inflorescence. Especially is this noticeable when the male flowers have suffered considerably. It is probable, however, that the destruction of male flowers has little influence on nut-fall, since an enormous amount of pollen is always available from unattacked flowers.

The female flowers are usually attacked near the point of attachment or on the "scales" which completely envelop the young flowers until just before the stigma becomes receptive. The damage is confined to the period before the opening of the spike, and if one is cut open a few hours before it bursts it will be found that the insect is in the final stages of its life history, only very few caterpillars being found. On the unopened spikes the presence of the caterpillars can be traced owing to numerous small gum-like beads which are mostly distributed over the apical portion of the spathe.

It has been found that an average of 65% of the female flowers is attacked in areas where the insect is prevalent.

Life History.

Considerable difficulty was experienced in working out the life history, especially in getting the moths to lay in captivity and in breeding the young caterpillars. Newly emerged adults were placed together on an unopened spike and confined in a small inverted funnel. They were moved to a different part of the spike or to a fresh one every day, and the surface examined for the presence of eggs.

At first the portion of the spathe carrying the eggs was allowed to remain until after the caterpillars had penetrated into the spike, but this method was abandoned owing to the difficulty of finding the minute caterpillars. Finally the portion carrying the eggs was cut out and kept in a moist chamber until the caterpillars hatched, when they were supplied with male flowers in small individual cages.

The moths usually copulated the day after emergence, but in some cases there was an interval of seven days between copulation and egg-laying. The proportionately long period between emergence and oviposition is noteworthy in relation to the opening of the spike, since many spikes on being opened are found to contain the moths as well as pupae. In the field the period from the first signs of attack to the opening of the spike is about three weeks.

A curious point was observed in connection with the copulation of the moths. In several cases the male died directly after copulation, on the same day, but remained attached to the female for one and two days after death. The females died two days after oviposition was complete and appeared to lay only one batch of eggs.

The life history has by no means been thoroughly worked out, but the available figures indicate that the cycle is short.

Summary of Life Cycle.

Incubation	...	2—3 days
Larval period	...	5—8 days
Pupal „	...	6—8 days

Total:—

Average	16 „
Maximum	19 „
Minimum	15 „

The eggs are laid in the longitudinal grooves of the spathe, never having been observed on the ridges. The caterpillars, on hatching, at once bore through the spathe, causing the gummy beads to form on the outside. Internally the points at which the larvae have eaten their way through are marked by brown discolouration extending for about a sixteenth of an inch round the minute hole. The larvae then confine their attention to the basal flowers of the inflorescence. When full grown they pupate in small oval-shaped cocoons at the base of the spike.

Control.

In view of the possible importance of this insect to the coconut industry, control experiments were instituted in Perak and later in Selangor.

The injection of carbon disulphide into the unopened spikes was tried, but quickly abandoned owing to the damage done to the flowers and to the impracticability of the method.

Efforts were them made to find a suitable substance with which the unopened spikes could be sprayed, or, in the case of dwarf palms, painted by hand. Spikes would have to be treated several times in the course of their growth, and such a method would only be practicable if the saving of nuts were commensurate with the labour expended.

A block of palms grown under ordinary estate conditions and suffering from a large amount of nut-fall was selected for experiment. Spike moths were prevalent on the area, and presumably were responsible for the yield being rather below the average. The plot consisted of 132 palms of eight to nine years of age which were cleaned up so as to be easily accessible by means of a ladder. The experiments on some trees had to be abandoned owing to the production of spikes with few female flowers, and in some cases work had to be

temporarily stopped owing to the presence of red ants (*Oecophylla smaragdina*, F.) and nettle caterpillars (*Setora nitens*, Walk.) The extent of the experiment was limited owing to the impossibility of examining a larger number of palms at regular intervals, and the very few insecticidal substances available.

Ten rows of palms were treated with separate substances by painting or spraying the spikes weekly from their appearance to opening. Two rows were used as controls. On opening, the number of attacked and unattacked female flowers was counted, and records taken of the fall of each. Distinctively coloured paint was applied to the flowers at the first examination to simplify the records of the fall of attacked and unattacked immature nuts. Records were obtained of 4458 female flowers on 362 spikes for control purposes, and of 1609 female flowers for a period of twelve weeks. The latter were used in order to ascertain the ultimate yield from attacked and unattacked flowers, since it was considered that after the twelfth week any injury due to the insect would be negligible.

The details of the control experiments are given in table I, showing the reduction of injured female flowers following the use of each substance compared with the number of flowers naturally attacked in the same area. All the substances were painted, with the exception of lead arsenate which was painted and sprayed. In the latter case very little beneficial effect was obtained, owing to the the lead arsenate not spreading efficiently over the spike.

In many respects the comparative value of the substances used is more a measure of their capability of spreading evenly over the peculiar surface of the coconut spike than of their actual insecticidal powers. Lead arsenate, used in four different media, shows varying beneficial effects which are attributed to the adhesive and spreading powers of the medium. Standard formulae were used in making up the insecticides.

TABLE I.—*Control.*

	Treatment.	No. of spikes	Total ♀ flowers	No. injured	% injured
	Control.	46	487	275	56
1	Tar oil (miscible) I -	23	371	37	10
2	Lead arsenate + sugar -	45	538	170	32
3	Rosin wash + Lead arsenate -	27	323	103	32
4	Tobacco + soap -	33	604	202	33
5	Lead arsenate – painted -	37	343	123	36
6	Tar oil (miscible) II -	36	434	160	37
7	Rosin wash -	27	372	140	38
8	Kerosene emulsion -	32	444	174	39
9	Bordeaux mixture -	20	219	98	45
10	Lead arsenate – sprayed -	32	323	176	54

TABLE II.—*Daily and weekly nut-falls expressed as percentages of the total female flowers present at opening of spikes.*

—	Day No.	Per cent.		Day No.	Per cent.		Day No.	Per cent.		Day No.	Per cent.		Day No.	Per cent.		Day No.	Per cent.	
		I.	U.		I.	U.		I.	U.		I.	U.		I.	U.		I.	U.
	1	—	—	15	1.432	.109	29	2.435	3.073	43	4.726	3 732	57	.429	.439	71	—	—
	2	—	—	16	.143	1.756	30	3.151	5.378	44	2.435	4.390	58	1.575	.878	72	—	—
	3	—	—	17	.716	1.317	31	4 154	3.732	45	1.575	.439	59	—	.548	73	.286	.109
	4	.143	.329	18	1.575	.219	32	.429	.768	46	.859	.109	60	.716	.439	74	—	.219
	5	.429	.219	19	1.002	.548	33	4.441	4.281	47	4.011	2.414	61	.143	.109	75	—	—
	6	.859	.219	20	1.146	2.744	34	.286	1.646	48	1.146	.768	62	.143	.329	76	.286	—
	7	1.146	.987	21	2 005	1.427	35	1.002	1.097	49	3.438	5.378	63	.143	.768	77	—	—
Weekly	1	2 577	1.754	3	8.019	8.120	5	15.898	19.975	7	18.190	17.230	9	3.149	3.510	11	.572	.328
	8	—	.439	22	1.289	1.975	36	4.011	6.476	50	.716	.548	64	.286	.548	78	—	—
	9	—	—	23	1.719	1.646	37	5.873	4.390	51	2.292	1.646	65	—	—	79	—	—
	10	.143	.439	24	.859	.109	38	2.292	.439	52	.429	—	66	—	.109	80	—	.109
	11	.859	.878	25	5.587	3.512	39	1.575	2.414	53	.716	.548	67	.143	.109	81	—	—
	12	1.289	.329	26	3.724	2.744	40	4.011	2.854	54	.859	1.756	68	.429	.109	82	—	—
	13	—	.878	27	1.289	1.756	41	—	2.963	55	.716	.329	69	.143	.219	83	—	—
	14	.286	.219	28	2.578	1.427	42	3.008	.987	56	.286	.987	70	—	—	84	—	—
Weekly	2	2.577	3.182	4	17.045	13.169	6	20.770	20.523	8	6.014	5.814	10	1.001	1.094	12	—	.109

I.—Injured flowers. U.—Uninjured flowers.

Nut-fall from other Causes.

During the course of the control experiments it was observed that a large amount of nut-fall occurred with nuts which had not been injured by *B. arenosella* or other insects. Certain palms were therefore selected with a view to ascertaining the total nut-falls which occurred, and the actual number of falls for which the insect was responsible; and records were kept of the fall of the injured and uninjured female flowers for a period of twelve weeks, the results being expressed as percentage daily and weekly falls in table II, and the accompanying curves.

From a total of 1609 female flowers, only 76 remained at the end of the period. This colossal fall, amounting to 95%, cannot be accounted for by insect injury; in fact the curves of the fall of flowers whether injured or not run very closely together. Of the 76 nuts remaining, 47 were uninjured and 29 were injured flowers. Expressed as percentages, however, there is remarkably little difference between the fall of injured and uninjured flowers. Of the 1609 female flowers 698 were injured and 911 were uninjured, giving percentage falls of 95.84 and 94.84 respectively. It will thus be seen that at the twelfth week the apparent damage caused by the insect is only 1%.

It may be argued that other causes effecting the fall of nuts mask the real damage caused by the insect, but such causes would probably act equally on both injured and uninjured nuts. On the other hand it is reasonable to presume that other causes acting on flowers already injured by the insect, would accelerate their fall, and this is what appears to happen in the earlier part of the falling-period.

It has been mentioned that a discolouration of the stem of the inflorescence occurs after insect attack, and this is especially noticeable where the male flowers have been injured. This may have an important influence on the fall of other flowers on the same spike, although they may not necessarily have themselves been attacked. Such conditions would undoubtedly increase the figure for the fall of "uninjured" flowers. To what extent nut-fall is caused by indirect injury of this nature must form the subject of another investigation.

If curve No. I, be examined it will be seen that the daily percentage falls are approximately the same for injured and uninjured flowers, except up to the 28th. day, and again on the 37th. and 47th days.

Curve No. II, gives the weekly percentage falls, and it will be seen that there is a slight predominance of injured nut-falls in the first week and a larger one in the 4th. A sharp drop occurs at the 5th week followed by a rise at the 6th. The most noticeable portion of the curve is that for injured flowers between the 3rd and 6th weeks. After the 6th week the curves for the fall of injured and uninjured flowers correspond closely.

The rise in the injured curve at the fourth week is attributed to the acceleration of the "normal" fall, due to insect injury. The rise in the first week can be attributed to direct injury by the insect, whereas that in the fourth week may be due to an acceleration of the fall of unpollinated flowers which would not normally occur until the fifth or sixth weeks.

The total fall of flowers increases rapidly from the second to the fifth week and is maintained for another week, when it reaches its maximum. In many ways the time of fall corresponds with that on which unfertilised flowers would normally fall.

Little work appears to have been done on the pollination of coconuts, but Jack and Sands (7) have worked on dwarf coconuts in this country. They state that self pollination, *i.e.* pollination from male flowers on the same spike, is the rule for the dwarf and tall palms, and not a somewhat rare occurrence.

Aldaba (8), however, working on the pollination of the tall coconuts in the Philippines, states that normal pollination takes place from other spikes on the same or different palms. He also states that female flowers do not become receptive until two or three weeks after the appearance of the inflorescence, and remain open for two or three days, after which they turn brown towards the stigmatic end, shrivel and die. The majority of falls were found by him to have been due to non-pollination.

The writer's investigations were in no way concerned with the pollination of coconuts, but owing to the large fall which occurred after the third week, and the casual observation that the female flowers become receptive at about the time stated by Aldaba, they formed the opinion that a considerable amount of nut-fall was due to non-pollination. It would be interesting to amplify the work done by Aldaba on the artificial pollination of coconut flowers. Gadd (9) working in Ceylon concludes that the fall of female flowers is the natural result of over-production, and that external conditions such as drought may adversely affect their fall. He further states that the fall of older but still immature nuts may be caused by fungus diseases, especially *Phytophthora*, and by mechanical or physiological causes.

Any or all of these causes may have been responsible for the fall of immature nuts not due to *B. arenosella*, and without concerted action on the same area it is impossible to ascertain the exact part played by each one. In so far as the direct injury by *B. arenosella* is concerned, it has very little influence.

The authors are indebted to Mr. H. T. A. Biddlecombe, without whose generous co-operation the work could not have been carried out, and also to Mr. W. Malcolm Miller.

Summary.

1. *Batrachedra arenosella* injures the flowers of the unopened coconut spike.

2. The eggs are laid on the spathe and the larvae bore into the spike. The life history is complete in about 16 days.

3. An average of 65% of the female flowers is injured in certain districts of Malaya. A control was found which on an area having 56% of the female flowers injured reduced the injury to 10%.

4. The yield of unattacked nuts was only 1% more than the yield from attacked nuts after the 12th week.

5. The majority of the nut-falls on the area was attributed to other causes.

6. The direct injury caused by *B. arenosella* is negligible.

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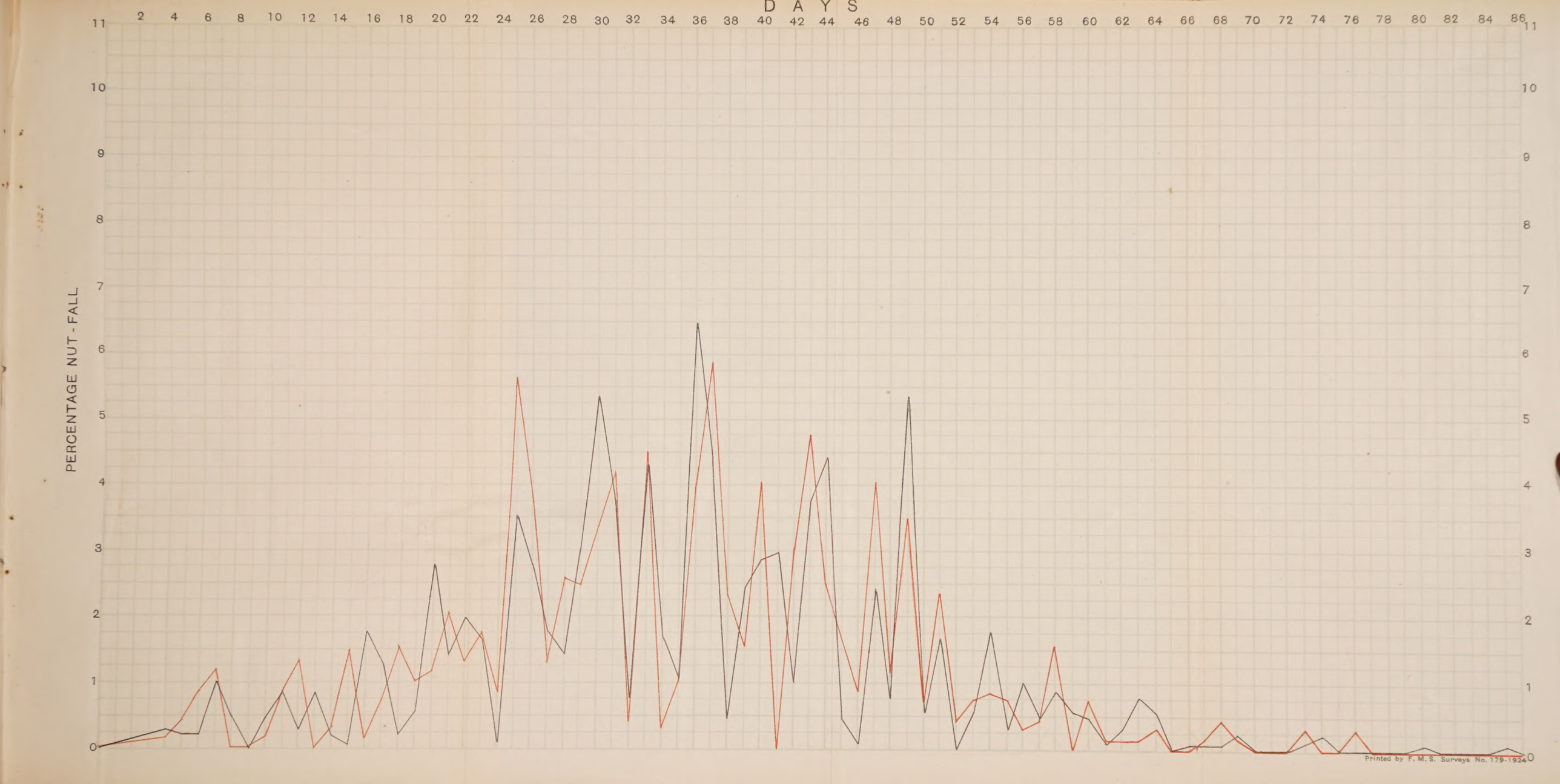
Received for publication 5th May 1924.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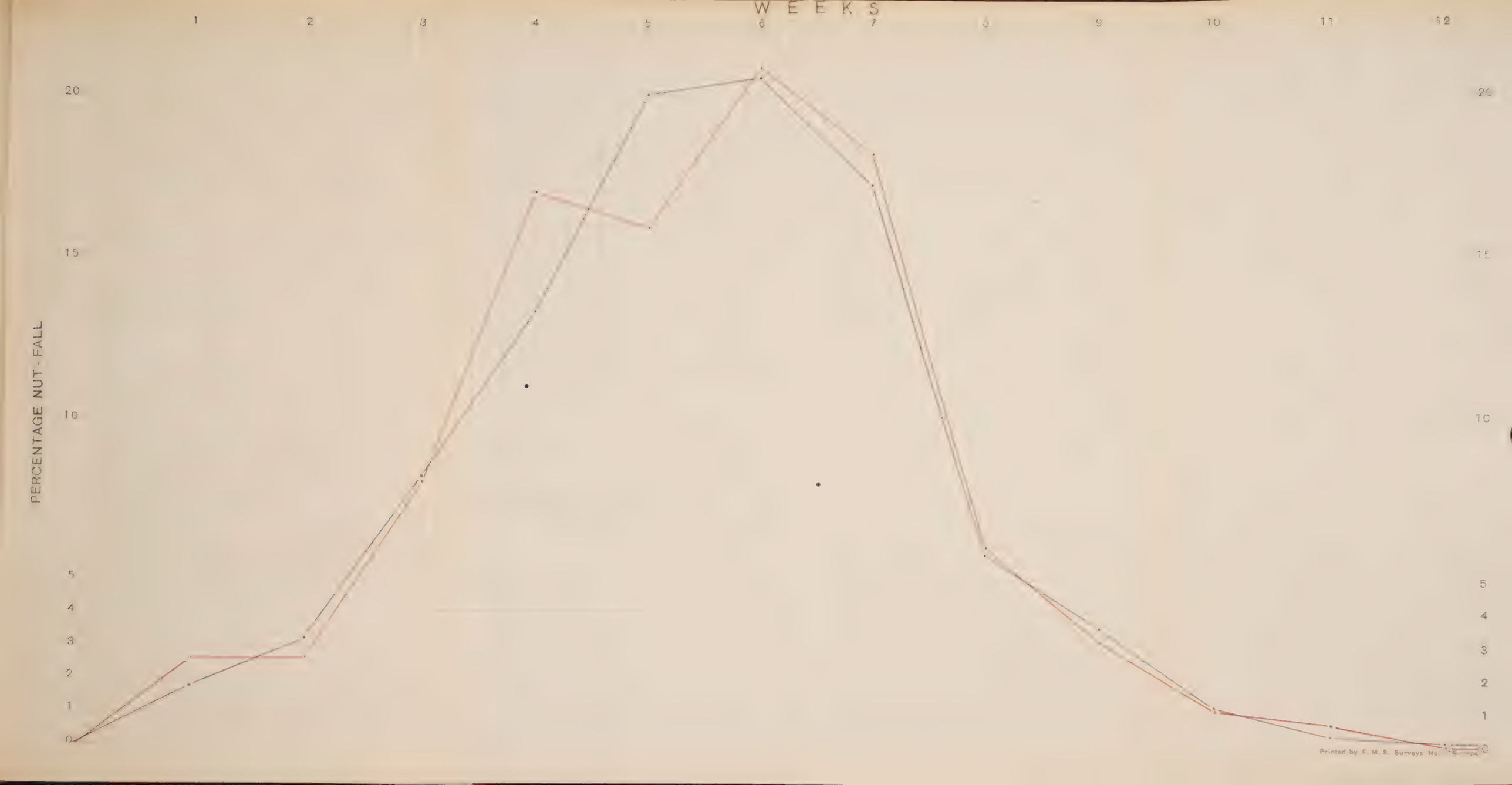
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EXPLORATION OF THE PERAK-PAHANG BORDER.*

Extracts from a letter from Mr. W. Cameron to H. E. the Acting Governor (the Hon'ble Cecil C. Smith, C.M.G.,) dated 4th September, 1885.

I have had a very successful expedition this time, and think it is the most complete and comprehensive piece of exploring I have done yet, as well as one likely to lead to practical results.

I have discovered Pahang to be a much larger territory than even I imagined, and I always knew it to be larger than was generally supposed. It impinges right up to the ulu of the Kinta and the Raia close into Perak just as it does at Ginting Bidei, and there is no intermediate nobody's land, except that this portion is totally unknown even to the Pahangites or to any Malays. There is in this place a sort of central hill country, a sort of vortex in the mountains, where for a wide area we have gentle slopes and pamah (plateau) land with round hills shut in all round by loftier ranges but which from the mean elevation of this vortex appear comparatively low, but the mean of the valley for many miles is 4,500 to 4,750 feet above sea level by aneroid. Streams of considerable size glide along easily from all around and go to feed one large stream eventually, and this is the Telom—the real ulu of the Jelei. I ascended one mountain at the N. E. corner of this Central land and looked down on the N.E. side to the real ulu (upper reaches) of the Kelantan, further east again behind a lofty range, Pahang, octopus-like, shoots out another arm to the north impinging on Kelantan. The mountain which I ascended was 6,300 feet by aneroid, probably considerably higher real altitude, and stands in somewhere about 4°38' North Latitude 10 degrees North of East. Of this a lofty mountain range rises closing in the vortex (to continue the simile) to the East (the vortex being the Telom). This lofty range I estimated to be over 8,000 feet, perhaps considerably more. I dared not ascend it, for not knowing what stream or system of streams I was on, I was obliged to hold on to the water-shed till it brought me right into Pahang known. I had no one who could give me any information, and the Sakias all fled before us, so that I had to be my own guide, and thus, as I say, was tied to this water-shed till I could make sure what it was, as I felt certain it would settle the question of the central watershed about which there have been various conjectures and it has solved the question, at least up to this point and a good way north of it.

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* These articles are reprinted at the request of the Hon. the Chief Secretary to Government. Mr. W. G. Maxwell C.M.G. It must be understood that the reprint has been made because of the historic interest of the articles, and not with any idea of the endorsement of the statements contained in them.

We had rather a trying time of it, owing to the fearful rains. Colds, fevers and rheumatism were our constant companions, and my men suffered very much.

I hope that I may have an opportunity of placing some of the results of this expedition more fully before you, and thanking you for your kind wishes.

I am etc.

Sd. WILLIAM CAMERON.

P. S.—I was fortunate enough to obtain particularly interesting geological data, of which I have brought many specimens and made copious notes. I should have stated generally that my route was up the Raia which I explored, the Ulu (Upper reaches) being unknown, as well as the Penoh which is an anak (tributary) of the Kinta. I crossed a mountain by a pass 5,300 feet by aneroid lying exactly at the Ulu of the Kinta, Penoh and Telom. This I have called Gunho Pass. I took the elephants over with me, explored this new country and followed the Telom till I got to within a day's sail of the place where it joins the Jelei. Long ere this all our stores but rice had been exhausted so for the purpose of supplies, and also because a rumour had got abroad in Pahang that I was a musoh (enemy) with forty elephants and four hundred men come down to harry and to raid, I had to reassure the authorities: I went down to Toh Kaya's and to Penjum by sampan, then back again and then crossed southerly all the rivers of Upper Pahang, keeping close to the foot of the main ranges and coming out over mountains 5,000 feet high at the Ulu of a tributary of the Slim, and thence on to Bernam.

I have reason to thank the Great Master that I enabled under his protection to bring my men back alive, although I cannot say well, for I on several occasions had great reason to be alarmed and feared some would succumb: there are several of them now under treatment, and one I left in the hospital at Penang.

The elephants, I am happy to say, notwithstanding the unprecedented fatigue, are well and in fair condition. By this time they will be pretty strong, for I left them at the Ulu of Sungkei to feed and rest eight days ago, and they will soon be in good condition. I am starting the relief party back again to-day by way of the Perak river and Batu Gajah and I propose taking a run down to Singapore for a day to get some outfit which cannot be procured here, when I shall do myself the honour of calling on you, but I must start my party first and I will meet them at the Bernam almost as soon as they can get there, as we are taking an additional elephant.

Intd. WILLIAM CAMERON.

ACCOUNT OF AN EXPEDITION.

To the Batang Padang Mountains, Perak, to Report on the Suitability of the Land for Planting Purposes.

By Mr. J. M. E. Cock,
Superintendent Government Plantations,
(*Perak Annual Hand Book and Civil Service List* 1892.)

In accordance with instructions received from H. B. M.'s Resident, on 16th March, I left Padang Rengas on the morning of the 18th to proceed on an expedition to explore the high mountains between Kinta and Batang Padang with a view to ascertain the suitability of the country for tropical agriculture, and, if practicable, to reach the plateau described by the late Mr. Cameron.

Mr. Fraser, of Waterloo Estate, a planter of many years' experience, accompanied me.

We proceeded via Penang, and arrived at Teluk Anson on the morning of Thursday, 24th. With Mr. Bowen's assistance, we secured a boat, and left Durien Sabatang at 6.45 a.m. 25th, reaching Tapah at 10 a.m. 27th *i.e.*, in two days 3¼ hours. We had been informed at Teluk Anson by the Superintendent of Lower Perak that Mr. Wray, the Collector and Magistrate of Batang Padang, was not expected back from Slim for some days.

We first went with Mr. West along the Chanderiang Road where his coolies were working.

We were favourably impressed with the soil and lie of land, unquestionably suitable for tea, Liberian coffee, and I presume, pepper. The banks of the cart road at present being cut by Mr. West through this land gives abundant evidence of quality and depth of soil, a free loam to an average depth of six feet where the coolies were working.

Next day Mr. West took us along through the Jungka Valley (well known for its mines rich in tin and also gold) towards Bidor to meet Mr. Wray. We met him about six miles along the road, when we all returned to Tapah. The Magistrate on his return found that he had to go to Chanderiang, so I accompanied him that evening, with the view of seeing as much of the country as possible. Returned on Wednesday, after examining the mines. We passed through a well-watered country, with rich soil, well adapted to grow coffee, tea, and probably pepper and cacao. The cart road under construction will develop this land, and, if taken up by planters at once, squatters will be prevented from occupying the best sites and cultivating the most favoured spots.

On his arrival from Bidor Mr. Wray had sent Penghulu Toh Baias to arrange about Sakeis (the aborigines of the country) as

baggage-bearers, and on Thursday the Penghulu came to report that we should be able to start on Saturday. Three elephants sent from Kinta by the Magistrate arrived this day, 31st March.

After a careful examination of the mountains from the Magistrate's bungalow, we resolved to ascend Gunong Batu Puteh first, to see the nature of the country, and from a prominent point to lay out our line of march for future operations.

We left Tapah on the afternoon of Saturday, 2nd April, passed through Kampong Brumen, Dan Dewa Sakti's home, where we saw mango trees growing from the seed which had been given him by the Resident on a visit in 1880. Reached Kuala Woh in the evening. The country we passed through on the north bank of the Batang Padang is drained by no less than fourteen streams.

On Sunday, marching along the north bank of Sungei Woh, we saw some good soil, but the subsoil was generally rather light and sandy. Mr. Wray was indisposed, and the elephants were making bad progress, so we halted at Batu Kacha about 1 p.m.

On Monday, 4th, Mr. Wray was much better. We sent Sakeis to bring up the goods from the elephants, sent elephants back to Kinta with a letter of explanation to Mr. Leech, established a depot at Batu Kacha, and proceeded on our way to the foot of Batu Puteh. We found Penghulu Toh Baias, who had been sent on before on purpose, had chosen a beautiful site for our camp on the bank of the Woh. This stream is famed for its turbulent, icy cold water. We had bathed and were making ourselves comfortable for the night when we observed the water come down in a wave about eighteen inches high, followed by another three feet high. In a quarter of an hour the water had risen 7½ feet above its former level.

Next morning (5th) started up the mountain. At the base passed through fine land, heavily timbered and well watered: would grow fine tea, pepper, cloves, cacao, &c. The rest of the day's march was over country too steep, in my estimation, for profitable cultivation. After five hours steady walking, we reached the late Father Scortechini's last camp, and were told that we were close to the top of the mountain. I went up after a short rest, and with some trouble got to the summit, only to find that there were mountains about 1,500 feet above me. The scene as viewed by me from a pinnacle of about ten feet square, my only companions a couple of shivering Sakeis, was indescribably solemn and grand. To the south, mountain on mountain extending down to the Slim; to the east, two tall mountains towering aloft shut out the view; high mountains to the north, almost continuous to Bujong Malaka on the north-west: and to the west open plain to the sea, the valley of the Batang Padang, Kinta and Perak rivers. Glimpses only of this to be had through the driving mist.

We were stirring betimes next morning (6th) and went to the top of the mountain, Toh Baias, in fear for our safety, having sent Sakeis on ahead to make ladders of rattan and cross sticks for the

steep portions. From the top we had an extensive and clear view of the valley of the Batang Padang, of Tapah, Jungka valley, &c. Mr. Wray took a few bearings, none too soon, as the mist was on us in a short time. We estimated the height of the mountain at 4,500 feet, and I have heard subsequently from Mr. Wray that he and his brother the Curator make it out to be 4,750 feet above sea level. In a southerly direction on the hills I have described as stretching towards Slim there is a good piece of undulating land at from 2,000 to 3,500 feet elevation, out of which about a thousand acres at least might be got suitable for cultivation. Again, in a south-westerly direction in a line with Tapah, at from 1,500 feet to 2,000 feet, a similar area is available. The land in the immediate neighbourhood of the mountain is too steep, in our opinion for agriculture. We judged it was quite unnecessary to make for the top of the true Gunong Batu Puteh, as from our elevated position we commanded a view of all the neighbouring mountains sufficient to enable us to decide upon our future course. The decision we came to was to make for the ulus of (1) the Woh and (2) Batang Padang. We were guided to choose those routes as they seemed most likely to lead us into coffee lands.

Struck camp at 12.30 p.m. and reached the camp at the bottom of the mountain in good time, bringing with us specimens of orchids from the trees and ground, also two varieties of adiantum, begonias, &c.

On Thursday, 7th we received supplies from depot at Batu Kacha; started in soaking rain up the south bank of the Woh; marched steadily on, fortunately leaving the rain behind, and arrived at camp at four o'clock. We camped at the base of a gigantic isolated block of granite, and were so well protected by the projecting top of concave face, that, though it rained during the night, we and our followers did not suffer. In front of our camp was a fine clump of giant bamboo, a cross section of the best joints being about six inches in diameter. The Sakeis called the camp in Malay Gua Basah (Anglice, Damp Cave), and the shelter rock Burong Gigit (Bird's Tooth). We were charmed with the shelter rock and its surroundings, and decided he would be a fortunate man who had an opportunity of opening a coffee estate there. The soil and jungle are both fine, the elevation about 3,000 feet, and a stream of water, cool and clear as crystal, within five minutes' walk of the Gua Basah. The soil may be classed as argillaceous free, dark on the surface from admixture of decomposed vegetable matter, and throughout of very superior quality.

For about two hours on Good Friday we marched through nice undulating land, soil rich, of good depth, elevation 3,000 to 4,000 feet; abundant water supply. Above 4,000 feet on this mountain the ground is steep, soil poorish, and jungle inferior, full of excellent rattan, which is useful in many ways on a coffee estate. Our baggage bearers halted at noon, commenced clearing away jungle so as to form a safe place for camp, and if possible get our clothes dried—we got soaking wet every day but one during this expedition. Our guides told us we were at the source of the Woh, and that the pass to Pahang

was close to us. Mr. Fraser had come bravely along, shivering with fever the most of the way from the camp of the previous night; so we left him and Toh Baias in charge of camp and started for the pass. Judging from glimpses we had of the country as we came along (we had been looking out anxiously for the pass) we were rather surprised when our guides took us up a steep face to the top of Gunong B'rapit. The way was materially shortened by the beauty of the surrounding jungle. As we ascended the trees became stunted, and covered with heavy loads of trailing mosses of different varieties. Embedded in the mosses were orchids innumerable, many of which were in flower. A bright sun was shining, pleasant breeze blowing, and the lovely valley of Pahang lay beneath us. Mr. Wray was soon busy with pencil and prismatic, but the clouds were on us shortly, and we had to desist from labour. To secure the advantage of commencing operations at dawn next morning, we resolved to camp on the top of the mountain. Accordingly, sent down our followers for provisions and what waterproof sheets could be spared from the camp, while we cut sticks to make a sort of gipsy-tent. Weather threatening when we went to sleep at dark, we were awakened in a couple of hours by a howling tempest of wind and rain: we thought we should be swept from the top of the mountain. We considered it advisable to shift from the most prominent point, the more so as we had noticed before it was dark the summit had a lightning-scathed appearance. Spent a miserable night, and were glad to get up and stretch our cramped limbs some time before dawn. There was a glorious sunrise; and a gorgeous panorama unfolded itself to our view.

Morning of 9th April. The Pahang country gets the first of the sun, and the advantage of this can be easily traced in the finer jungle on the eastern slopes as compared with the western. On the eastern side of the range, too, the jungle appears to roll on gently and gracefully—a contrast to the rugged though more picturesque view on the western ranges. It has therefore many natural advantages for agricultural enterprise. Mr. Wray having resumed his labours of the previous day, about noon, we had a lasting record of the principal features to the north, west, and south from this mountain. We reached the camp shortly after mid-day, and after refreshments busied ourselves arranging the rich spoils from the jungle in the shape of orchids, adiantums, &c.

Mr. Fraser accompanied us up next morning, 9th, as also did Toh Baias. Gunong B'rapit is about 5,000 feet above sea level, pass below into Pahang less than 4,000 feet. Mr. Fraser agrees with me that on the eastern slope fine land for coffee is to be had, with everything in its favour if a little more accessible. We saw Gunong Hifan bearing 310 deg., Waterloo 307 deg., Bubu 299½ deg., Kledang 303½ deg., and in valley of the Batang Padang a promising looking block of land which we called the Horse-Shoe Valley, with eastern aspect and apparently from 2,000 to 3,000 feet elevation. This block, which is not very extensive, and the land in the neighbourhood of the Goah Basa, already described, seemed to be the most tempting for cultivation of Arabian coffee, but, if a commencement were made, it would be difficult to say what land would and what land would not be opened, as steepish lands possess advantages which make practical

planters value them quite as highly as land of easy lie. We had accomplished our object in exploring the Ulu of the Woh. Our next was to make for Ulu Batang Padang. This we wished to do by marching north over the mountains either by the western or eastern slope. When Penghulu Toh Baias heard of our intentiou he said the thing was impracticable, there being no tracks. On our proposing to cut a track he said the Sakeis declined to accompany us, and no amount of persuasion would move them ; so reluctantly we were compelled to return by the route we came. It was easily seen that all the Penghulu's knowledge of the country was derived from the Sakeis, and, very properly, he was always accompanied by one or two Sakeis who knew the country.

We left on the morning of Monday, 11th, and reached Tapah on the evening of the 12th.

Mr. Fraser, who had thoroughly enjoyed his trip, and whose knowledge and experience had been of great assistance to me in forming an opinion on the capabilities of the country we had passed through, considered it his duty to return to his charge at Waterloo from this point, much disappointed at not being able to explore further.

Penghulu Datoh Toh Baias as far as Batu Puteh was energetic and helpful ; after that stage his energy flagged, and he seemed to enter a passive protest against the expedition proceeding further. This arose from the conservatism innate in most Malays : he desired that things should remain as they were, and saw elements of change and confusion invading his territory in the shape of the members of this expedition. His action threw us in more direct contact with the Sakeis, and we found that several of them could talk Malay fairly well. All through the expedition the Sakeis behaved splendidly. They are an active, hardy race, many of them of fine physique, deep-chested, and strong limbed. They will play an important part in the future development of the resources of the country.

Our followers did not reach Tapah till the day after our arrival, and then dispersed to their several homes.

All the Penghulu's fire and energy were excited in collecting a force for the second expedition, but it took him some time to get a band together.

We left Tapah on the 16th, and after waiting a day at Kwala Woh, on Monday, 18th, we accomplished a short days' march along the north bank of the Woh to Luba Manoh, where we arrived at noon. The country we traversed was well suited for tea cultivation, soil good and deep, and, apparently, from the number of streams crossed, rainfall abundant. Left Sakeis making huts, and accompanied Toh Baias to Lumpong, where he went to procure extra men.

On the 19th we passed through some fine country, abundantly watered, and arrived at camp rather late in the afternoon.

On the 20th Mr. Wray found his ankle so painful, having twisted it on our rather rough journey the day before, that he could not put his foot to the ground. I left for the hill above our camp, on the other side of which we expected to find the horse-shoe valley observed by us from the top of Gunong B'rappit on the morning of the 9th. Datoh Toh Baias and Klana, Mr. Wray's krani—a first rate jungle man—and Sakeis accompanied me. We could see very little from the top of this mountain, on account of high jungle, very steep on the western side. We returned to camp at 4 p.m., in pouring rain.

On the 22nd Mr. Wray was fit for travel again. We proceeded through some very fine land, leaving Sungei Batang Padang behind us, and camped on the banks of Sungei Singum. The land here is worth more than a passing notice. We had come through the valley of the junction of the Sikum and Singum with the river Batang Padang. The country was apparently more open, and the soil richer than anything we had seen before on this journey, with exception of some of the land we saw on the 19th. The surface soil is rich and dark, the subsoil deep, rather yellowish, of a loamy nature. This is unquestionably a soil of great fertility : tea would certainly flourish in it, and would find no obstacle in the way of throwing its strong-growing tap-root deep into the ground. I have seen cacao grow well in soil inferior to this. Here and there boulders of rock cropped up, which, without interfering at all with the depth, improved the quality of the soil, their gradual detrition adding mineral wealth to the vegetable mould deposited by the luxuriant jungle. On enquiry we found that our guides had left the valley of the Batang Padang and taken us up the Singum, near the source of which lay the Laut Tungal or Solitary Sea, as it may be freely interpreted, the locality of which had been pointed out to us from Gunong B'rapit.

On the 23rd, as our object was to explore as much of the country as possible and as quickly as possible, we sent the main body to take up their quarters on the Batang Padang, while we started in light marching order (with nothing but our instruments) up the Singum. The line of march in the early part of the day took as through country the most of which had been cleared by Sakeis, on which jungle of a secondary growth had sprung up. The original forest, where it existed, was fine, and we saw great tracts of it lying in a north-westerly direction.

From Gunong Chenum Prah we got a good view of the country, and could see that all the best land in the valley between us and Ulu Woh had been under cultivation. We formed a very favourable impression of the soil from a Sakei ladang we passed through, where tapioca and other food stuffs were flourishing in a good black loam. On reaching the Laut Tungal we found it was marsh, as we had suspected, surrounded by heavily-wooded hills. We returned through a smart rain-storm to our deserted camp on the Singum, and on to the new camp on the Batang Padang. The Laut Tungal may be put down at from 3,000 to 3,250 feet above sea level. The soil is good, and the day may not be far distant when there will be a branch road leading up the valley of the Singum through estates of tea and coffee.

We had become pretty well accustomed to wading up the beds of streams and scrambling over slippery rocks, but the route of this Sunday, being principally up the bed of the Batang Padang, was particulary rough. Our view was intercepted by the steep banks of the river, and we did not see much of the country.

On Monday (25th) morning, which was bright and fine, we came to a place where the Batang Padang tumbles over a succession of precipices, first one then another, and at last there is a sheer fall of over a hundred feet, forming a beautiful waterfall, the spray from which was to be seen glistening in the morning sun for a considerable distance. We named it the Bridal Veil Fall. We then scrambled up the steep side of the ravine, crossed the stream at the top of the falls, and up a very steep hill-side, seeing some good country stretching towards the west in the direction of the Ulu Singum. Struck the valley of the Batang Padang again, and reached the spot selected for a camp for the night. We could see we were not far from the source of the Batang Padang, the volume of water being so very considerably reduced. We left the men forming camp and went straight up the hill in front of us. Soon found ourselves in the region of dychridiums and orchids similar to those found at Gunong B'rapit of the Ulu Woh. Marched on in hopes of reaching an eminence whence we could obtain a view. Without any very appreciable alteration in altitude, we entered a region well watered, with rich soil and magnificent timber. We both agreed it was the finest forest we had ever seen. We ourselves decided on our route for the following day, after finding the old Sakei guide was beyond the limit of country known to him. Returned to camp just before dark, well pleased with our afternoon's work.

Left a most uncomfortable camp next morning early, and proceeded rapidly over country traversed the previous afternoon. Found little Sakei boy and one of our followers sitting up a tree watching the monkeys that were holding high chorus in the neighbouring trees, and, by questioning him, gathered sufficient information to make us wish for more, so Klana went up a high tree (being an old sailor, this was an easy matter for him). He took his bearings for the highest mountain to be seen, and led the way in a more northerly direction than we had intended. The result proved he was right, for we were not long in reaching the top of a high mountain, and his skill, combined with the industry of the Sakeis, soon afforded us a ricketty ladder up a monster tree. From these we saw a higher mountain ahead of us, in an easterly direction. Dispatched impedimenta in charge of Datoh, who undertook to find water and make a camp while we and Klana struck right up the mountain ahead, full of hope we had reached the Gunong Brambun the Resident had viewed from Tapah. We had some hard cutting through rattan before we reached the top of the mountain. This hill had high trees right on the top, so we could do nothing more than fix on a good tree on which to erect a "crow's nest" next morning. The trees were festooned with moss, and almost every tree had its quota of orchids, many of which we were fortunate enough to see in flower. We reached the camp in the evening, which was situated at the very source of the Batang Padang. We congratulated ourselves on having carried on our expedition so far successfully.

Wednesday, 27th, made an early start, accompanied by Klana and eight Sakeis, to the point we had gained the previous evening. Klana made a crow's-nest, which reflected great credit on his skill. A driving mist gave us only passing glimpses of the surrounding country, and it was only after exercising great patience that we got a sketch of the country, and took bearings. Another crow's-nest had to be made on a mountain immediately south of us in order to see the country on that side. Waited on till past four in the hope of getting a clear view, in vain.

Next morning, Thursday, we were early at our point of vantage, and had a glorious view of the country from an elevation of apparently close on 5,000 feet: mountains surrounded us. The country to south and south-west we had seen most of from Batu Puteh and Gunong B'rapit. Beneath us was the pass into Pahang, at the source of the Sikum: from the nature of the ground, we judged it was about 1,500 feet below us. Some easy slopes on the eastern exposure of those southern mountains were suited in every way for coffee cultivation. Turning north-east we looked straight at what was probably pointed out to the Resident as Gunong Brambun, it being the highest mountain near us; to the north and west a great extent of easy, billowy land, delightful to the eye of a coffee planter; heavy forest, well watered, and open to the morning sun.

To arrive at an estimate of acreage we saw and to give an idea of the nature of the country, I will compare it to the well-known and much-visited coffee district in Ceylon-Dimbula, as viewed from the Dimbula Gap, looking south-east towards Manoya—the same broken, rugged outline bounding each, the mountains running down to the low country, in the case of the Brumbun district (as it may not inappropriately becalled), the same as happens in the Dimbula Valley at Meddecoombera. The extent of country seen may be safely put down at thirty miles long, and, though as broad as five miles in places, owing to the broken nature of the country, it would not be safe at present to estimate more than 30,000 acres available for cultivation, though when every separate valley in this large district is surveyed very likely three times this extent will be developed. From a very rough sketch the late Mr. Cameron made to show me the position of the land he discovered, and from a letter written by him which appears in the Straits Asiatic Journal, June, 1885 (for extract from which I am obliged to Mr. Wray) I gather that we were very much south of the land he means. It is just probable we saw it in the distance, and that it formed the extreme northern end of the country we looked into.

This is unquestionably the coffee district of the State. Other places are more accessible, but the area is very limited. Here the extent is vast: and when one considers what has been done in Ceylon by the State and by private enterprise in opening up communication with mountainous regions, without looking at the political importance of having a highway into the important eastern State of the Peninsula, the task before us here is comparatively speaking, easy.

The soil all over this State upon the hills is deep and rich, and on the Batang Padang mountains is of a very superior quality. Sir Graham Elphinstone, when he visited the Waterloo estate in 1884, remarked particularly on the admirable quality and freeness of the soil there, especially on the eastern slopes. Again in March, 1886, when he visited the Government experimental plantation near the Hermitage, he was equally pleased with the soil, and classed it as a sandy loam.

In estimating elevations we had to be guided by our own experience by the nature of the herbage, and by comparison with mountains of fixed altitude. The figures given by the aneroid kindly lent me by Mr. Mais, of the Survey Office, Taiping (and about which he warned me) are apparently correct up to a certain height, but beyond that are entirely unreliable.

The Hermitage, 23rd August, 1887.

PAPAIN.

By B. J. Eaton.

ARTICLES on "Papain, its production and uses" and "The Preparation of Commercial Papain" were published by the writer in the Agricultural Bulletin, Vol. II, No. 7, February 1914, pp. 190—192 and Vol. V, Nos. 5 and 6 February—March, 1917, pp. 202—203.

The information contained in the present article embodies that previously published, together with additional information from other sources and replies received from various firms in England, Canada and America which are interested in this product.

Source of Raw Products.—Papain is a proteolytic or digestive enzyme contained in the juice of the fruit and other parts of the Papaya tree (Carica papaya).

The commercial product, which consists of a cream coloured or white powder is obtained from the fruit of the tree.

Cultivation.—The papaya tree, as is well know, grows extensively in Malaya and other eastern tropical countries and other parts of the tropics, including tropical Australia and is grown largely for its fruit.

There are three kinds of trees (*a*) hermaphrodite or perfect flower (*b*) female or pistillate (*c*) male or staminate. The trees are propagated from seed, which should be sown in a well prepared seed bed about ½ inch apart. The seeds should be covered lightly with soil and the seed beds should be well watered. The beds should be shaded and, if the seeds are sown during rain, the beds should be sufficiently protected to prevent the washing away of the seeds.

The seeds germinate in about 2—4 weeks and may be transplanted when about 3 inches high. The plants should be watered before transplanting and three fourths of the leaf blades should be removed to prevent wilting. The soil should be well pressed round the roots and the seedlings planted at about 10 feet apart. Cover crops may be grown on the land. Water should be supplied, if the plants tend to wilt. The plants however will not tolerate a water-logged soil. The trees begin to bear fruit after about one year and the fruit may be tapped to obtain the juice when they are three months old. Only mature, but not ripe, fruit should be tapped.

Cattle manure is applied largely in India in the cultivation of the tree. The following mixed fertiliser has also been found to be very successful in Hawaii—Superphosphate 800 lbs., sulphate of potash 315 lbs., nitrate of soda 250 lbs., sulphate of ammonia 190 lbs., volcanic ash 445 lbs. Ploughing and harrowing during the early stages of growth, are also recommended in India.

If properly looked after, the plants may last for 5 to 10 years but the period of profitable production is said to be 3—4 years. Special fruits, varying in size and shape, can be produced by adopting suitable breeding methods.

Composition of Fruit.—Analysis of the fruit has given the following results: —

	Per cent.
Water	90.75
Protein	0.80
Oil or Fat	0.10
Nitrogen Free Extract	6.32
Fibre	1.09
Ash	0.94

The most important constituent is the digestive or proteolytic enzyme—papain.

Preparation of Crude Papain.—The juice, which contains the papain, is obtained by making shallow longitudinal incisions, about ⅛ inch deep, in the unripe but well grown fruits, by means of a non-metallic knife (a bone or ebonite knife). Rustless steel knives will be satisfactory if it is found that they do not discolour the juice.

Fruits, in which only three to four incisions are made simultaneously, can be incised again after a day or two but, if seven to eight incisions are made, subsequent tapping is said to yield very little juice or latex. The juice resembles a white thin sticky latex, which coagulates rapidly.

The fruits should be incised in the early morning and the juice strained through muslin and dried at about 35°C for two days, when it forms a cream coloured brittle mass with an unpleasant odour. The mass can be ground to a powder.

The juice should be collected in glazed earthenware or china cups. A trace of formalin added to the juice prevents decomposition. Small quantities of juice may be dried in the sun on sheets of glass. Large quantities however are prepared preferably by spreading the juice on linen trays made by stretching brown linen on wooden frames placed over a hot-air chamber of brick, avoiding excessive heat. This can be done by using an iron plate covered with 2-3 inches of sand between the fire and the hot air chamber, with the trays about one foot above the plate. Artificial drying in this way should be done below 100°C (below 40°C); on a large scale vacuum drying would be found to be very efficient. The juice contracts on drying and the contents of several trays can be placed subsequently in one to complete the drying. The juice should be dried till it is crisp and capable of being reduced to a powder. A cream coloured or white powder is obtained.

The yield of crude dried material amounts to about 16-18 per cent. of the weight of the juice.

The yield per tree will depend on locality and amount of fruit. A tree with thirty fruits may yield 1 lb. of crude papain. A dozen shallow cuts about ½-¾ inch part on a fruit of good size will yield ½ oz. of papain.

One authority gives 0.4 lb of fresh latex per tree while 40 fruits have yielded the same amount. In Ceylon the yield is from ½ to ¾ lb. of papain per tree. In India the trees are planted 400 to 500 per acre and the cost of cultivation, collection and preparation of papain is estimated at 200 to 250 rupees per acre.

Purification and Standardisation of Papain.—The commercial product is said to be often adulterated with starches. The "activity" number (i.e. the amount of protein digested in a fixed time at a definite temperature by unit weight of papain) varies considerably.

By Pratt's method (digestibility of casein from milk) commercial samples from Ceylon gave "activity members" from 0.5 to 9.7. Mexican samples have given 12.9 and West Indian samples 40.0. Philippine samples, prepared in the laboratory, of fresh latex (on dry basis) gave 45.8, undried latex (on dry basis) 45.4, alcohol precipitated papain 72.2 and Indian samples 44.4 on egg albumin.

(NOTE :—Pratt uses a 40 per cent solution of a sweetened condensed, skimmed milk as substrate and a 0.5 per cent aqueous solution of papain.

25 ccs of milk, with 23 ccs of water and 2 ccs of a filtered papain solution containing 5.m.grams of papain per c.c. mixed and at the end of the digestion period (30 minutes at 40°c) the undigested casein is precipitated by adding 0.5 ccs of copper sulphate solution (6 per cent.) followed by 0.5 ccs of glacial acetic, with vigorous stirring during the precipitation. The precipitated casein is broken up, washed on a filter, dried in an oven and weighed. A blank experiment is used as a control. This method has been adopted by subsequent experimenters in the Philippines, on account of its reliability and simplicity.

Brill and Brown of the Philippine Bureau of Science (The Philippine Journal of Science Vol. 20 No. 2 Feb. 1922 p. 185) state that papain appears to lose its activity on keeping ; a sample examined by Pratt in 1914 which digested 85 per cent. of the casein in milk in 30 minutes, had lost all its activity in 1921, although the dried material had been sealed up in small glass vials and protected from sunlight.

These experimenters found that alcohol-precipitated papain is more active than sun-dried papain. By dialysis of the milk (a 10 per cent. solution of a dried milk powder was used, instead of the sweetened condensed skimmed milk employed by Pratt) to remove minerals salts, greater activity was shown.

These experimenters conclude that autolysis of papain takes place at temperatures as low as 0°C when the enzyme is put in water with toluene as an antiseptic. Sodium chloride shows first a slightly activating effect followed by an inhibiting effect in more concentrated solutions; sodium carbonate and bicarbonate and calcium chloride, magnesium sulphate and boric acid have no marked effect; potassium chloride and sodium citrate showed marked activation while acetic and lactic acids showed strong inhibiting effects.

The following method of purification has been applied in India:— 20 grammes of fresh latex are stirred with 100 ccs of 95 per cent alcohol producing a white gummy coagulum. The alcohol is poured off and a further 50 ccs of alcohol added to the coagulum, which crumbles to a fine powder. The powder is filtered and washed with ether to remove a semi-solid yellow wax and to facilitate drying. The washed papain is dried in vacuo and gives a pure white powder, amounting to 3 grammes, equivalent to 15 per cent. on the fresh latex. The papain is tested by using 15 ccs of egg albumin made up to 25 ccs with a 1 per cent solution of sodium chloride to which 1 cc of papain solution (0.01 papain) is added. The mixture is digested for 15 minutes at 80°C. The following results were obtained on different samples of papain :—

(*a*) Juice dried at 35°C, (Neutral). Protein digested 55.9 per cent.

(*b*) Dried juice extracted 10 times with water for 6 hours and filtered ; extract precipitated with 2 volumes of 91 per cent. alcohol and dried in desiccator. (Neutral.) Protein digested 51.0 per cent.

(*c*) Fresh latex precipitated with 2½ volumes of 91 per cent. alcohol and dried in desiccator. (Neutral). Protein digested 56.8 per cent.

(*d*) Latex treated as in (c) and then washed with ether after drying for one day and then dried in desccator. (Neutral). Protein digested 67.1 per cent.

(*e*) Fresh latex precipitated with 5 volumes of 94 per cent. alcohol and washed three times with ether, and dried in desiccator. (Neutral). Protein digested 57.7 per cent.

(*f*) As per (e) but solution acid. Protein digested 2.8 per cent.

(*g*) As per (e) but solution acid. Protein digested 2.8 per cent.

These results indicate that the papain prepared from the juice by precipitation with alcohol and subsequent washing with ether gives the most active product.

It will probably however be preferable to leave the purification to the manufacturers who purchase the raw product and to prepare a good dried juice on the estate.

The following points in the preparation should be noted :—

(1) The juice should be dried as soon as possible.

(2) The drying should be effected below 40°C, otherwise the activity of the papain will be reduced or destroyed.

(3) Final drying is effected preferably in a vacuum drier.

(4) The product should be ground to powder and packed at once in air tight stoppered bottles or lead-lined wooden boxes.

Further experiments indicated a remarkable activity when the digestion of the protein (Egg albumin) was carried out at temperatures as high as 90 to 95°C. in acid or neutral solutions, which seems remarkable.

(*Note.*—Details of the above experiments are contained in " The Phillippine Journal of Science Vol. 20, No. 2, February 1922 p. 185 and " The Agricultural Journal of India Vol. XVI, No. 5, Sept. 1921).

Markets & Value.—The following information has been received in reply to a questionnaire addressed to various firms in England, Canada and America

Firm A. (New York. U.S.A.) Imports into United States of America for year ending June 30th 1914. Papain extract—39,419 lbs. valued at $74,866 gold. From Germany 94 per cent, From England 6 per cent. Papain "select"—6, 181 lbs. valued at $26,613 gold.

Germany—89 per cent, Holland—8 per cent, British West Indies—3 per cent.

The product described as "Select" is probably a dry crude papain. The crude papain, which is now imported, is packed in bags and fetches $1.50 to $1.75 per lb. C.I.F. New York (December 1922). It is usually sold on test. The amount imported at present is probably about 50,000 lbs. per annum.

Firm B. (England). No information of any value.

Firm C. (Canada). The dried juice should be packed in a tin, glass or jar container and sealed. The product should be bone-dry.

This firm imports juice from its own estates, packed in ordinary kerosene or gasoline tins.

Firm D. (England) This firm quotes prices from four different wholesale lists as follows:—(A) 3/2 per oz. (B) 2/6 per oz. (C) 3/2 per oz. Merck's-22/2 per lb.

Firm E. (England) No information of any value, except as to packing in air-tight containers. This firm states that there is a very restricted market in London, as papain seems to have largely gone out of use in medicinal preparations.

Firm F. (England) Market price (Sept. 1922) 7/3 per lb. The product should be packed in lead lined cases, containing about 56 lbs. There is a fairly good demand for the product, which is sold on test. It should be free from sugar and starch.

Probably between 250 & 500 lbs. per month could be taken.

Firm. G. (England)—branch of New York Firm A.—Market in London very limited and consignments sent to England appear to have been chiefly exported again, The United States of America the chief consuming country.

The above replies appear to indicate that the chief consuming country is America.

The present price of this product is 3/2 per oz. in London and $2/15 to $2/25 gold per lb. in 10 lbs. bottle (U. S. Pharmacopoeia) Powder or $1/85 to $1/90 per lb. Crude, in 150 lb. cases.

Conclusions.—The cultivation of the Papaya tree for the production of papain should be an economic proposition on a small scale. The plants could be grown with other crops; coffee, or Kapok could be grown if the papaya tree are planted widely.

Received for publication 10*th March* 1924.

CASHEW NUT OIL.

By C. D. V. Georgi.

IN a previous number of the Malayan Agricultural Journal, Vol. X, Nos. 10, 11, 12, October, November, December 1922 an account was given of some experiments which had been carried out with Cashew nut oil, as a result of a suggestion that it might be possible to utilise this oil in pharmaceutical preparations in a similar way to Almond oil. Samples of the oil, both crude and refined by caustic soda to remove the free fatty acids, prepared in this department were sent to the Malay States Information Agency, London for valuation.

Results of Examination.

Samples of the crude and refined oils were submitted by the Agency to the Imperial Institute for examination. An extract from their report is as follows:—

> "These results (physical and chemical constants of the oil, compare table in article referred to above) show that the cashew kernel oil closely resembles almond oil in most of its constants, but that there is a wide difference in the solidifying points of the fatty acids obtained from the two oils.
>
> The samples of both the crude and purified oils were submitted to the test specified for almond oil by the British Pharmacopoeia *viz.* that the oil must remain clear after exposure for 3 hours to a temperature of -10°C, and should not congeal until about -18°C. In both cases however the cashew kernel oil failed to comply with these requirements."

Another point noted by the Imperial Institute was the large amount of stearine (solid fat) which had separated from the oil. This separation takes place only in a cold climate, as in this country cashew nut oil will remain quite clear, even after standing for a year.

Conclusions.

The conclusions arrived at by the Imperial Institute are as follows:—

> "The results of chemical examination show that cashew kernel oil, after refining with soda and partially removing stearine, could be used as an edible oil. In view however of the high price realised by cashew kernels in the United Kingdom for confectionary and dessert purposes, *viz.* about

£8 per cwt. (December, 1923.), it is probable that it would be more profitable to export the kernels than the oil.

Neither the crude nor the purified oil would be suitable for use in Pharmacy as a substitute for almond oil, as the cashew kernel oil does not possess all the properties of almond oil."

Received for publication 12*th February* 1924.

NOTE ON THE USES OF RAW RUBBER.

By B. J. Eaton and J. H. Dennett.

EXPERIMENTS are being carried out in the Chemical Division of the Department of Agriculture on the effect of exposure of various types of raw rubber to atmospheric conditions.

In these experiments the samples of rubber are being dusted with various powders and sulphur is also being incorporated in samples.

Although the experiments are not yet complete, they shew (a) that smoked sheet is superior to unsmoked sheet and crepe in resisting atmospheric conditions. (b) that the dusting of powders over the surface of the rubber has a protective effect.

It has also been found that rubber with which sulphur or antimony sulphide (which contains free sulphur) is incorporated is much more resistant than raw rubber. A sample of crepe rubber, containing about 4 per cent. of sulphur incorporated on an ordinary crepeing machine, after exposure for six months with no protection, exhibits no sign of tackiness, but the rubber feels slightly harsh to the touch.

The reason for this is possibly solar vulcanisation. Luff in a recent communication in the India Rubber Journal, has shewn that sulphur will combine with rubber under such conditions.

The incorporation of sulphur with pale crepe in the manufacture of pale crepe soles will therefore probably produce a product which may be superior to the raw crepe sole. The incorporation of about 4 per cent of sulphur gives a slightly yellowish tinge to the rubber. Similarly black soles for use on black boots can be made by incorporating lampblack and sulphur while red soles for brown boots and shoes can be made by mixing a small proportion of antimony sulphide with the raw rubber. These chemicals can be incorporated on the crepeing rolls without affecting the final character of the sole crepe.

Samples of such soles have been prepared and sent to the Agricultural Section of the Malayan Pavilion of the British Empire Exhibition.

A sample of smoked sheet has been used on the footboard of his car by an officer in the Federated Malay States Railways' Department for about eighteen months and at the request of the Secretary for Agriculture was examined recently by one of us.

The following observations were made :—

The rubber shewed no signs of wear but had developed (a) a permanent set (b) softening and loss of a considerable proportion of its original resilience.

Permanent set takes place very readily in raw rubber, owing to its comparatively poor elastic properties. The effect of a periodic load of about 150 lbs. on the rubber had produced this permanent set. This set however is not of great importance in the case of rubber used for such a purpose. The softening and loss of resilience is due to the exposure to the atmosphere.

The most important feature however is the fact that the sample has not become "tacky." This is due to the facts mentioned in our experiments above viz. (1) smoked sheet is more resistant than crepe in this respect and (2) the continuous covering of the surface of the rubber with fine dust particles, which confer protective properties on the surface of the rubber. The latter is the chief reason for the absence of the tackiness. The effect of powdering with dust particles is part of a general phenomenon, the protective action of certain powders on the surface of raw rubber, on which investigations are being carried out in the chemical laboratories. The use of pieces of smoked sheet for such purposes is economical and the first cost is very low.

Another use for thin sheets of rubber is the under sides of mudguards of cars. The attrition caused by the impact of small gravel etc., which wears away the paint, is the chief cause of the rusting and perforation of mudguards. If thin sheets of raw rubber are attached to the under sides of such mudguards, they would prevent this attrition and consequent rusting.

One enterprising estate manager has actually made inner tubes of raw rubber and also used raw rubber bands as an extra tread on his tyres.

Received for publication 27th February 1924.

NOTES ON THE EXPERIMENTAL PLANTATION, SERDANG FOR THE MONTH OF APRIL, 1924.

NEW planting material received during the month included cuttings of Kikuya grass (*Pennisetum longistylum*) from Ceylon; cuttings of the following grasses.—Australian Blue Couch (*Digitaria didactyla*), *Zoysia pungens*, and a native species known to the Malays as 'terapoh' or 'tebu salak' (*Coelorrachis glandulosa*). Seeds of two cover crops, *Centrosema pubescens* and *Crotalaria anagyroides*, native of South America, were received from the Netherland East Indies. Cuttings of *Mikania scandens*, a twining herb, met with in hedges and the borders of jungle throughout the Peninsula, were obtained from the Experimental Plantations, Kuala Lumpur, for trial as a cover plant. Although not leguminous it is considered to be of possible value as a cover plant on account of its dense habit and rapid growth.

A number of the Candle Nut trees (*Aleurites triloba*) planted out in the field during November 1922, commenced to flower during the month. The seeds of *Aleurites montana*, received from Hong Kong, have now germinated and it is hoped to plant up an area of this tree in the near future. In this connection it is interesting to note that the trees at the Kuala Lumpur Experimental Plantation have flowered irregularly since December, 1923, and apart from its possible value as a crop of economic importance, it is a desirable tree for planting in Malaya on account of its large white flowers, borne in terminal showy masses.

The fifty acre block of African Oil Palms (*Elaeis guineensis*) has been examined for Crown Disease and it is found that 7 per cent. are at present showing signs of this disease. Fortunately the palms appear to suffer no permanent ill-effect and in time recover without any traces of the disease remaining. The disease is common in new areas of this crop in Sumatra and a percentage of 10 per cent. of diseased palms is frequently seen.

Rain fell on 22 days during the month giving a total rainfall of 18.31 inches. The heaviest rainfall in 24 hours was 4.3 inches on the 8th on the month. These are the highest totals yet recorded on the plantation for any one month and any one day.

The maximum shade temperature was 95° F. and the minimum 69° F. The average maximum shade temperature was 92° F. and the average minimum 71.4° F.

The total run of wind during the month was 1470.4 miles, and the average run for 12 hours from 6 a.m. to 6 p.m. was 39.42 miles and that from 6 p.m. to 6 a.m. 9.6 miles.

(5-5-24).